

Economic Benefits from Oceanographic Research

a special report of the
Committee on Oceanography
National Academy of Sciences—National Research Council

Publication 1228
National Academy of Sciences—National Research Council
Washington, D. C.
1964

Benefits and Costs

(See Appendix for calculation procedure)

BENEFITS DISCOUNTED TO THE TIME WHEN RESEARCH IS DONE

It can be expected that both new production and savings resulting from oceanographic research will increase with time. If the rate of increase is proportional to the production or the savings, these will increase exponentially with a doubling time of T years. If the value of the annual new production or the annual savings T years from now is B , then the average annual benefit realized over a given time, t , starting at the present time, is approximately:

$$\frac{0.693 B t}{2T} \left[1 + \frac{0.693 t}{3T} + \left(\frac{0.693 t}{T} \right)^2 \frac{1}{12} \right].$$

When t is 20 years, this becomes:

$$6.93 \frac{B}{T} \left(1 + \frac{4.62}{T} + \frac{16}{T^2} \right).$$

For example, when T is 15 years, the average annual benefit over 20 years will be 0.64B; for $T = 10$ years, it will be 1.12B; and for $T =$ seven years, 2.0B. The estimated value of B for each economic benefit we have considered is given in columns 3 or 4 of Table 1. We estimate that this value will be reached during the future year shown in column 5.

The National Oceanographic Program calls for a total federal expenditure over a 10-year period. For simplicity in calculation we have assumed that the funds will be evenly spread over this period, and that the annual rate of research expenditures will be the same for the following 10 years. We have also assumed that any given year of research is equal in importance to any other in producing the economic benefits attained during all subsequent years.

To judge the value of oceanographic-research expenditures in comparison with other possible ways of employing the same money and human effort, we must reduce the anticipated future economic benefits to their "present worth," that is, their value at the time the research is carried out. This is equal to the immediate return on an investment at compound interest that would yield the same future return as the research. The rate of interest is called the discount rate. Because the likely results of research are always uncertain, this would be a fairly risky investment, and consequently we have used a high discount rate—10 per cent. An investment today of 37 cents at 10 per cent compound interest, starting immediately, would yield the same return 10 years from now as an investment of a dollar at that time. An investment of 22 cents today is worth a dollar 15 years from now.

With our assumption that the rate of oceanographic-research expenditure is constant, and that the economic benefits in any year should be discounted back to the times when the research expenditures are made, the discounted value of the average annual economic benefits becomes:

$$\frac{0.693Bt}{2T} \left(1 + \frac{0.093t}{3T} - \frac{0.1t}{3} \right)$$

$$\text{which for } t = 20 \text{ years} = 6.93 \frac{B}{T} \left(0.33 + \frac{4.62}{T} \right)$$

That is, the discounted average annual value is about half of the total average annual value of the benefits from oceanographic research.

RATIO BETWEEN BENEFITS DIRECTLY ATTRIBUTABLE TO OCEANOGRAPHIC RESEARCH AND COSTS

The savings and production increases listed in Table 1 will require other expenditures beside those for oceanographic research. As the table shows, we estimate that the fraction of the discounted benefits directly attributable to such research varies from 10 to 100 per cent.

These values must be weighed against the cost of the research. In Table 2 we have shown how the planned budgets for different agencies in the National Oceanographic Program might be allocated to various economic benefits. These allocations are arbitrary, but they seem reasonable in the light of present activities. The sum of the allocations to a particular area is given in Table 1 as the annual cost of the research that will produce the indicated annual economic benefit. The total of all these costs is 166 million dollars, whereas the average annual expenditures contemplated in the 10-year National Oceanographic Program, plus the Navy's oceanographic expenditures outside the program, are 280 million dollars. The difference, 114 million dollars per year, is allocated to national defense.

The fractional discounted benefits divided by the corresponding costs are given in column 10 of Table 1. These estimated benefit/cost ratios vary from 4.8, in the case of long-range weather forecasting, to 0.8 for improvements in ship design. The over-all average is 3.2: that is, the direct return on a 20-year investment in oceanography will be more than three times larger, during those 20 years, than if the same money had been invested at 10 per cent compound interest.

Benefits and Costs Discounted to the Present Time

In evaluating investment decisions, economists usually discount total future returns and costs to their value at the present time, rather than to some future time when the expenditures may actually be made, as we have done in the preceding section. Columns (11) and (12) of Table 1 show the present values of the total anticipated benefits during the next 20 years

that should be directly attributable to oceanic research, and the corresponding present values of the total research costs. Benefit-cost ratios are given in column (13). It will be seen that these are higher than the ratios obtained if the benefits and costs are discounted to the times when the research is done. For example, the average benefit-cost ratio computed by this method of discounting is 4.4, compared with 3.2 by the previous method.